



"Only I can prevent forest fires? What's fire?"

Fred X. Turck

Before striking the match!

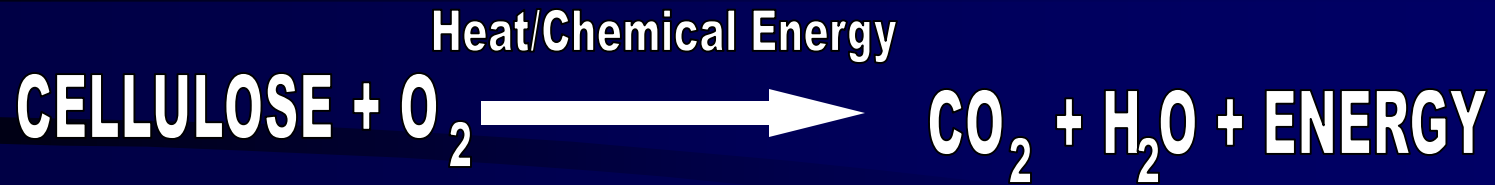


Virginia Department of Forestry

*Protecting and developing healthy, sustainable forest resources*



# CHEMISTRY 101



# Fire Triangle



Heat

Oxygen

Fuel

# Heat Transfer



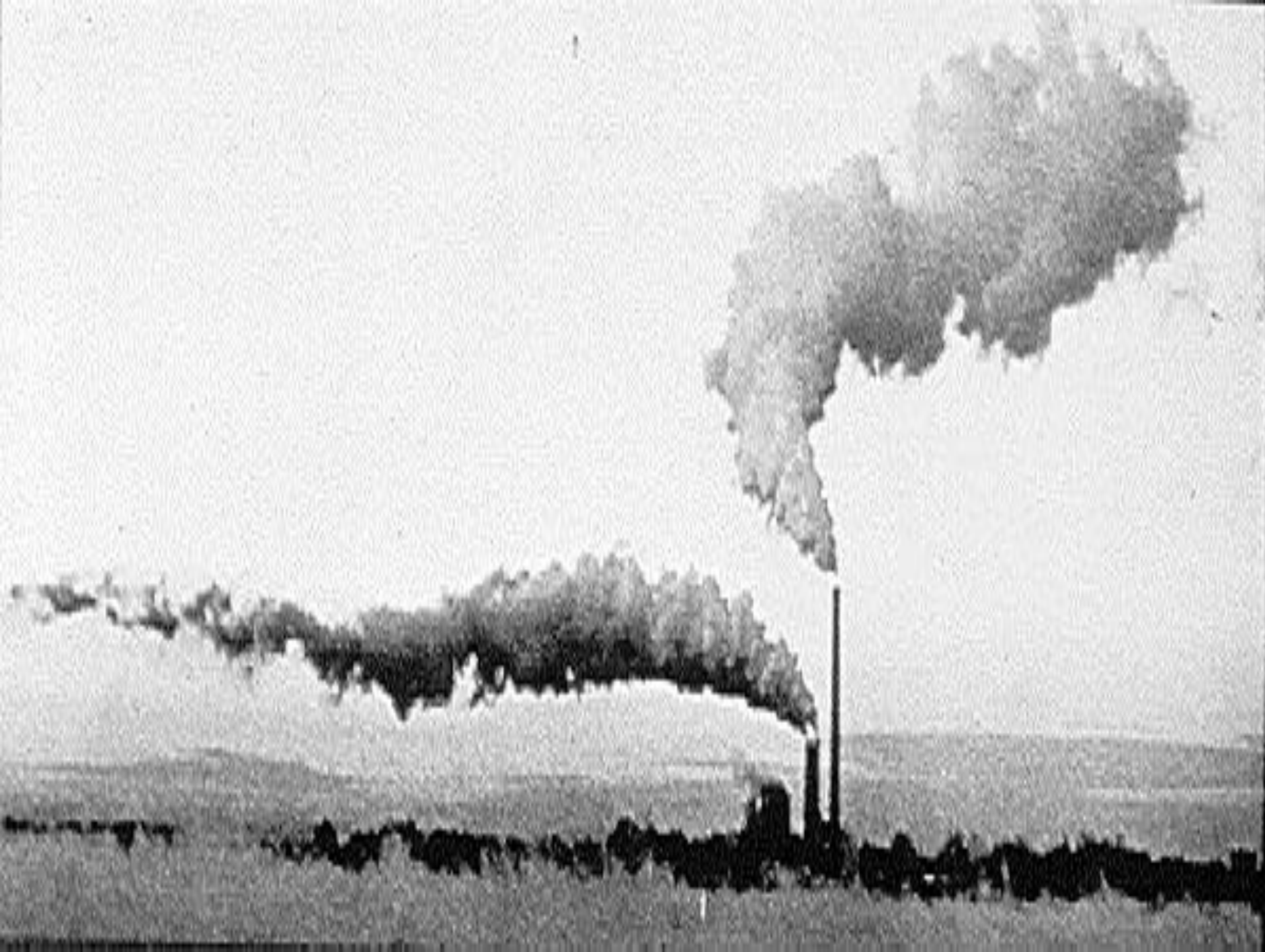
**Radiation**

**Convection**

**Conduction**

# Smoke Production





# Smoke Management

- **A plan of action where prescribed burning is conducted in such a way that smoke produced is minimized or directed in a direction that keeps any impacts within acceptable limits.**

# I-4 PILEUP

JAN. 9, 2008 • POLK COUNTY

Smoke and fog were a deadly combination Wednesday morning in Polk County when 70 vehicles were involved in 10 crashes along Interstate 4, producing 4 fatalities, injuring 38 and leaving many questions.



# Smoke Management Costs

- Reduce number of burning days
- Constraints on acreage burned
- False starts
  - Delays until later in the day, year or next year
- Extra cost of mop-up
- Monitoring costs

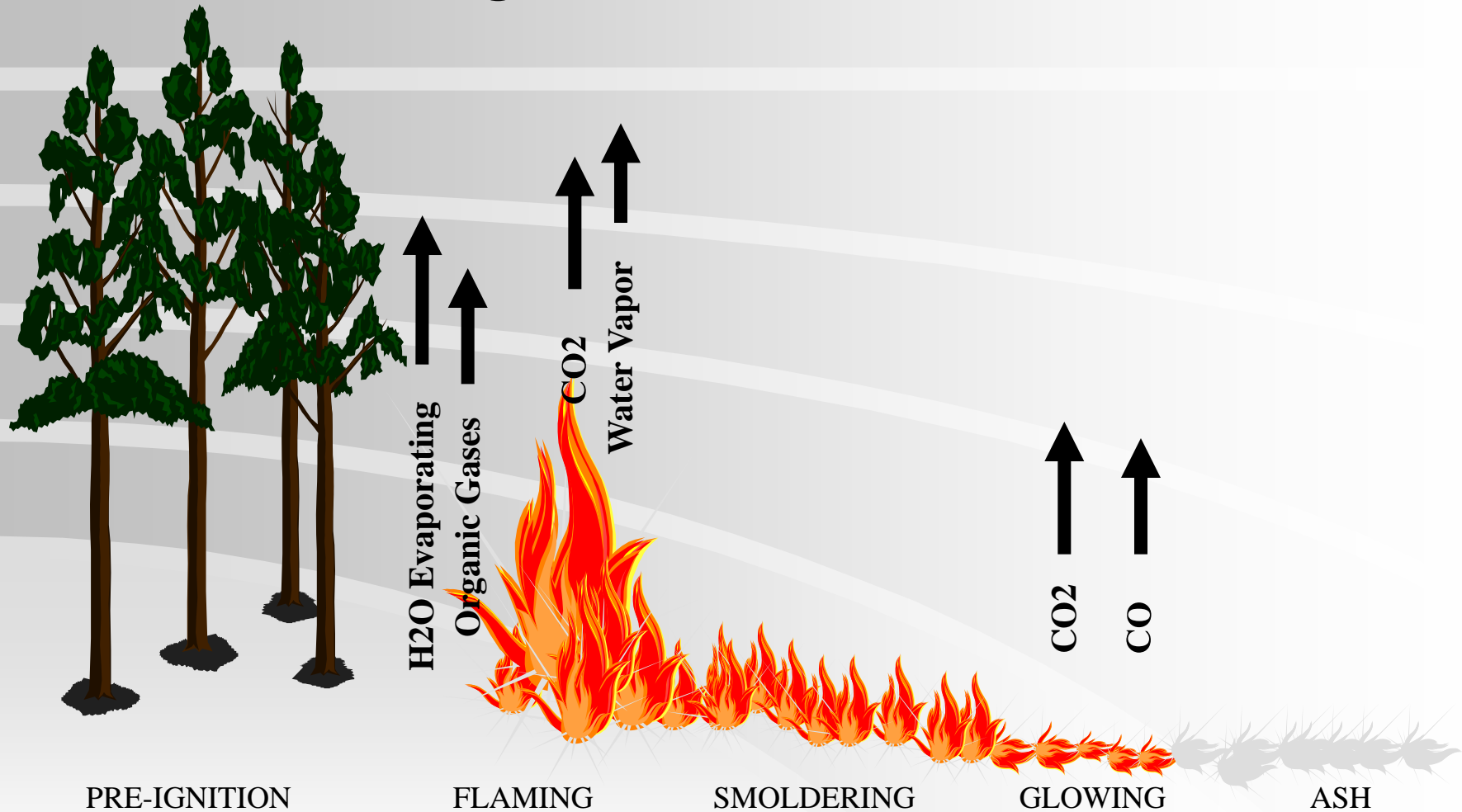
# Smoke Management Benefits

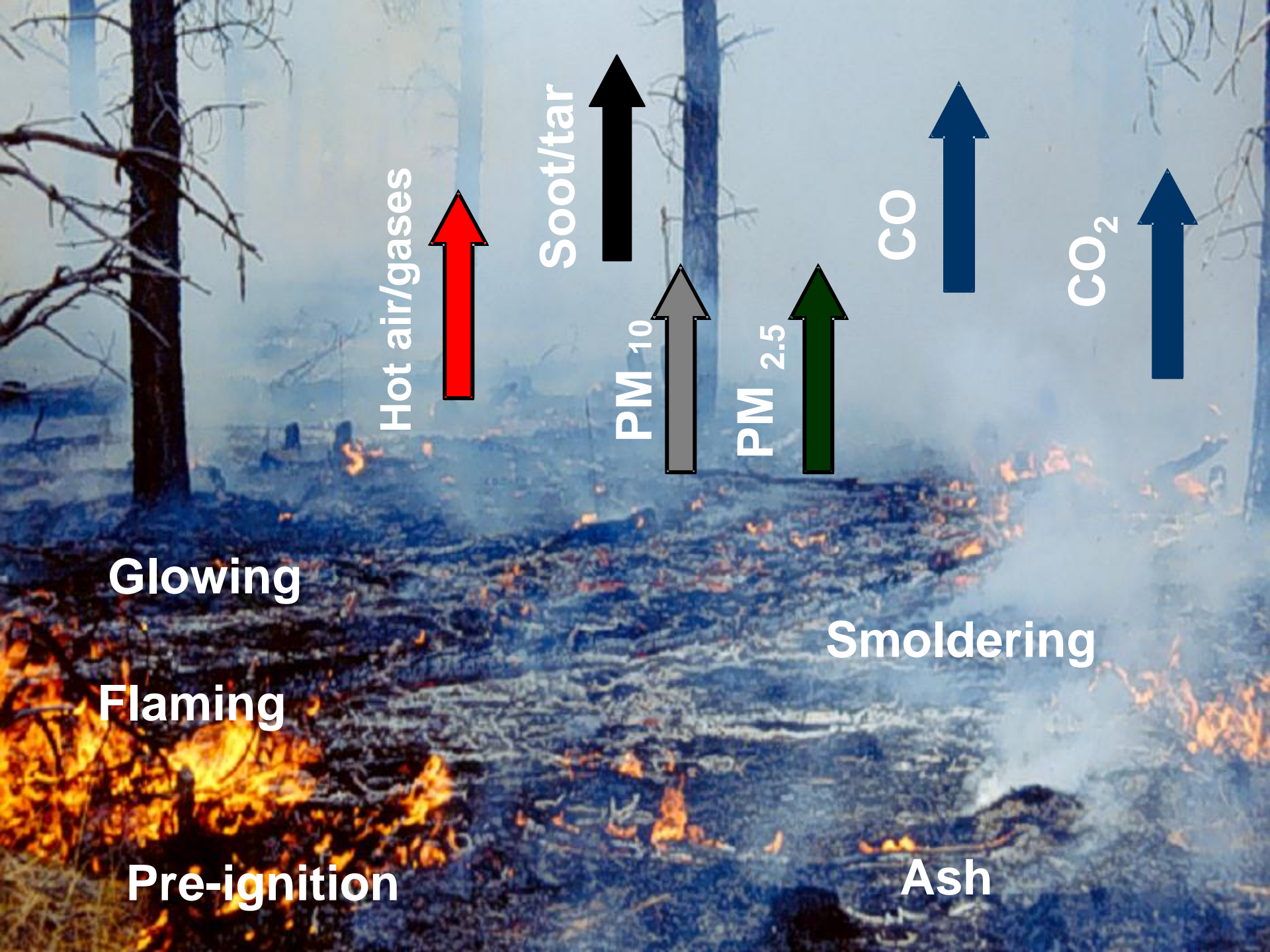
- The continued use of prescribed fire as a management tool
- Improved air quality through fewer smoke intrusions
- Fewer public complaints
- Reduction of litigation and liability costs

# Pollutants

- The most important pollutants given off during a wildland fire are particulate matter and carbon monoxide.

# Stages of Combustion





Hot air/gases



Soot/tar



PM<sub>10</sub>



PM<sub>2.5</sub>



CO



CO<sub>2</sub>



Glowing

Flaming

Smoldering

Pre-ignition

Ash

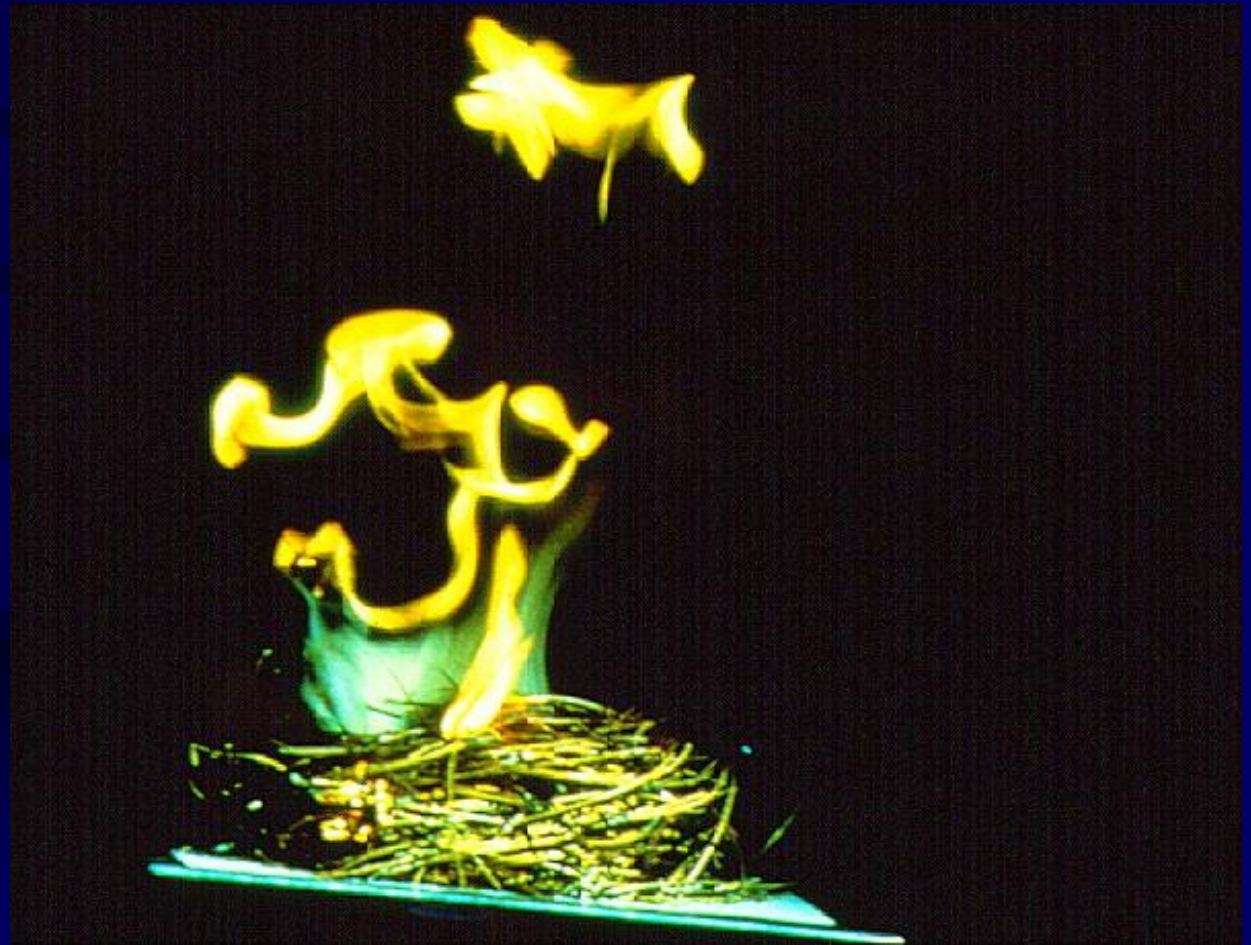
# Stages of Combustion - Pre-ignition

- Pre-ignition - As fuel is heated, combustible gases and vapors are released.



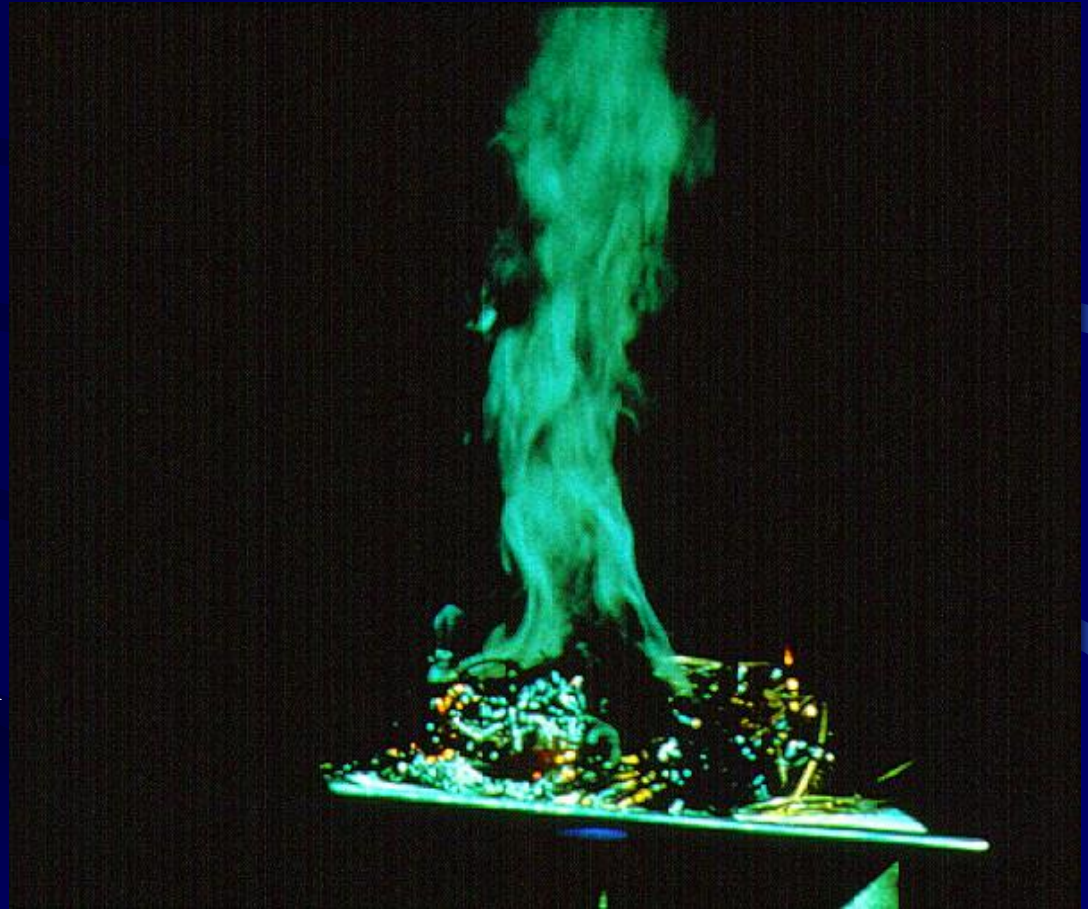
# Stages of Combustion - Flaming

- Flaming phase major products:  $\text{CO}_2$  &  $\text{H}_2\text{O}$ .
  - Organic compounds released
  - More inefficient the burning, the more soot and tar produced.



# Stages of Combustion - Smoldering

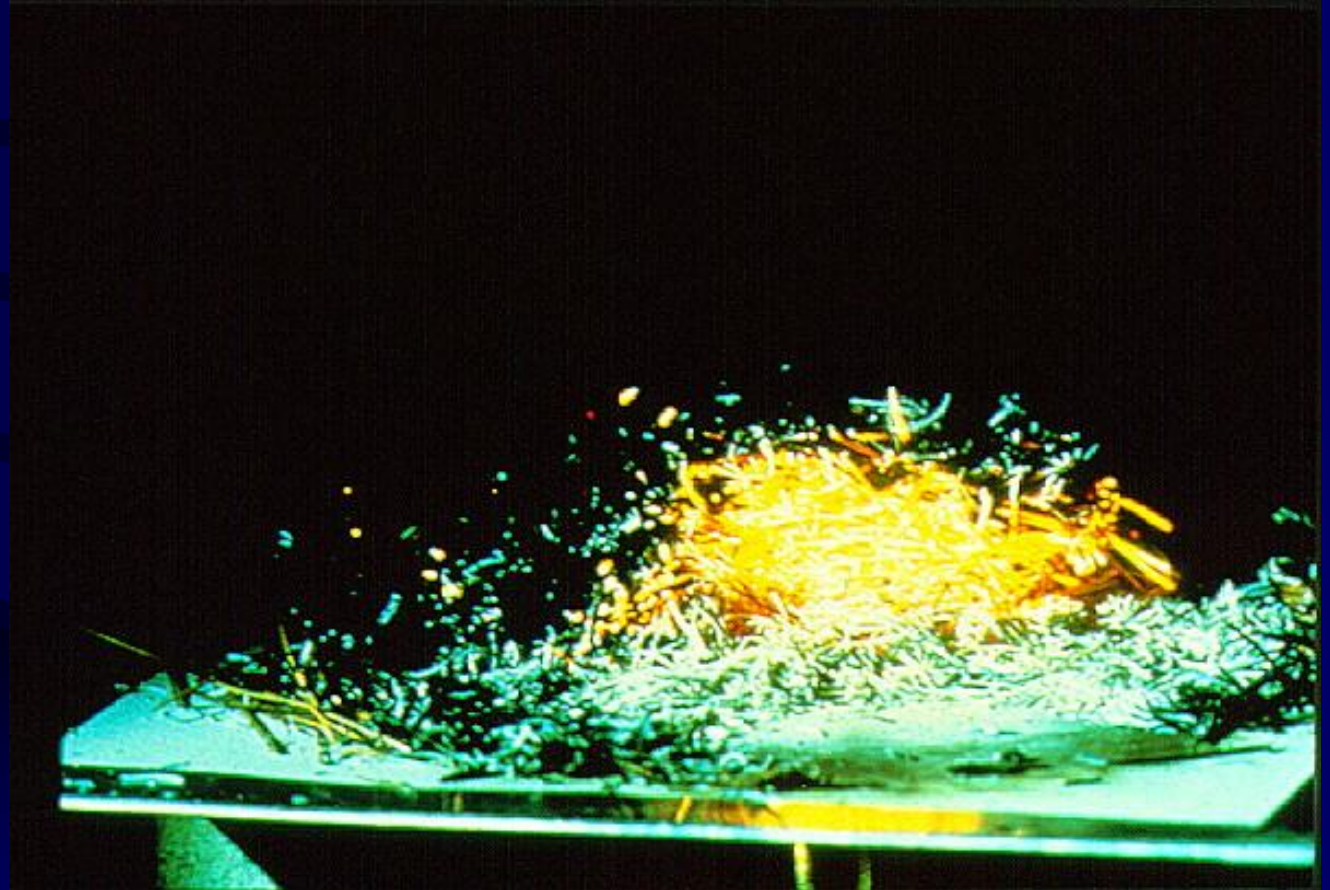
- Most Critical Stage
  - More smoldering with head fires
  - Smoldering fire emissions 2 X that of Flaming fires
  - Residual Smoke - smoke produced by smoldering combustion not contained in convective column





# Stages of Combustion - Glowing

- No smoke problems



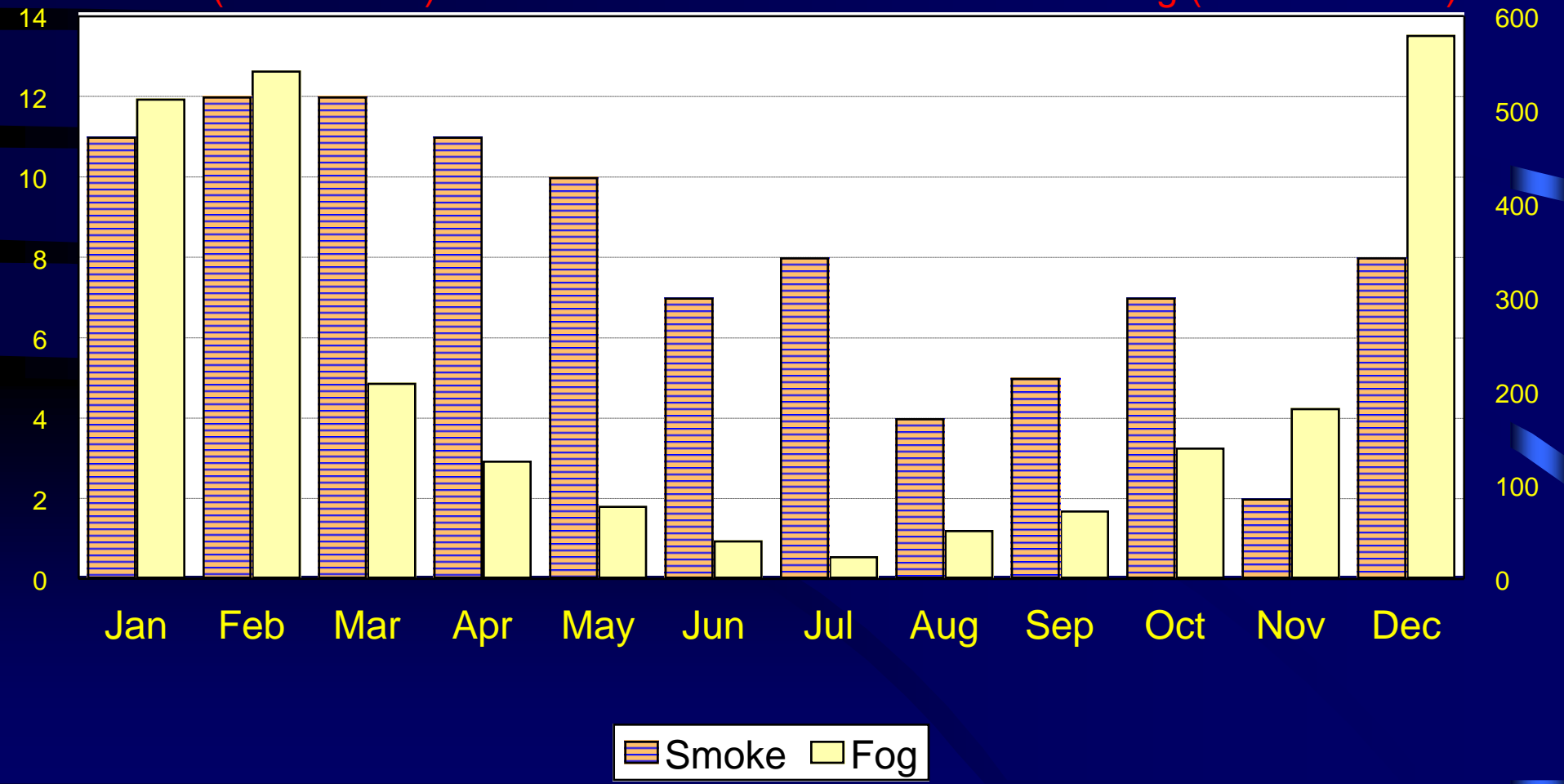
Residual smoldering combustion (RSC), is define as combustion occurring after the convective- plume phase of a fire has ended; often lasting for many hours or days. It has been estimated that 50%, or more, of fuel consumption can occur by RSC under the driest conditions.

Smoke generated by RSC can drift down-slope (especially at night) into smoke-sensitive areas. In combination with local inversion conditions, this may lead to air quality violations or complaints.

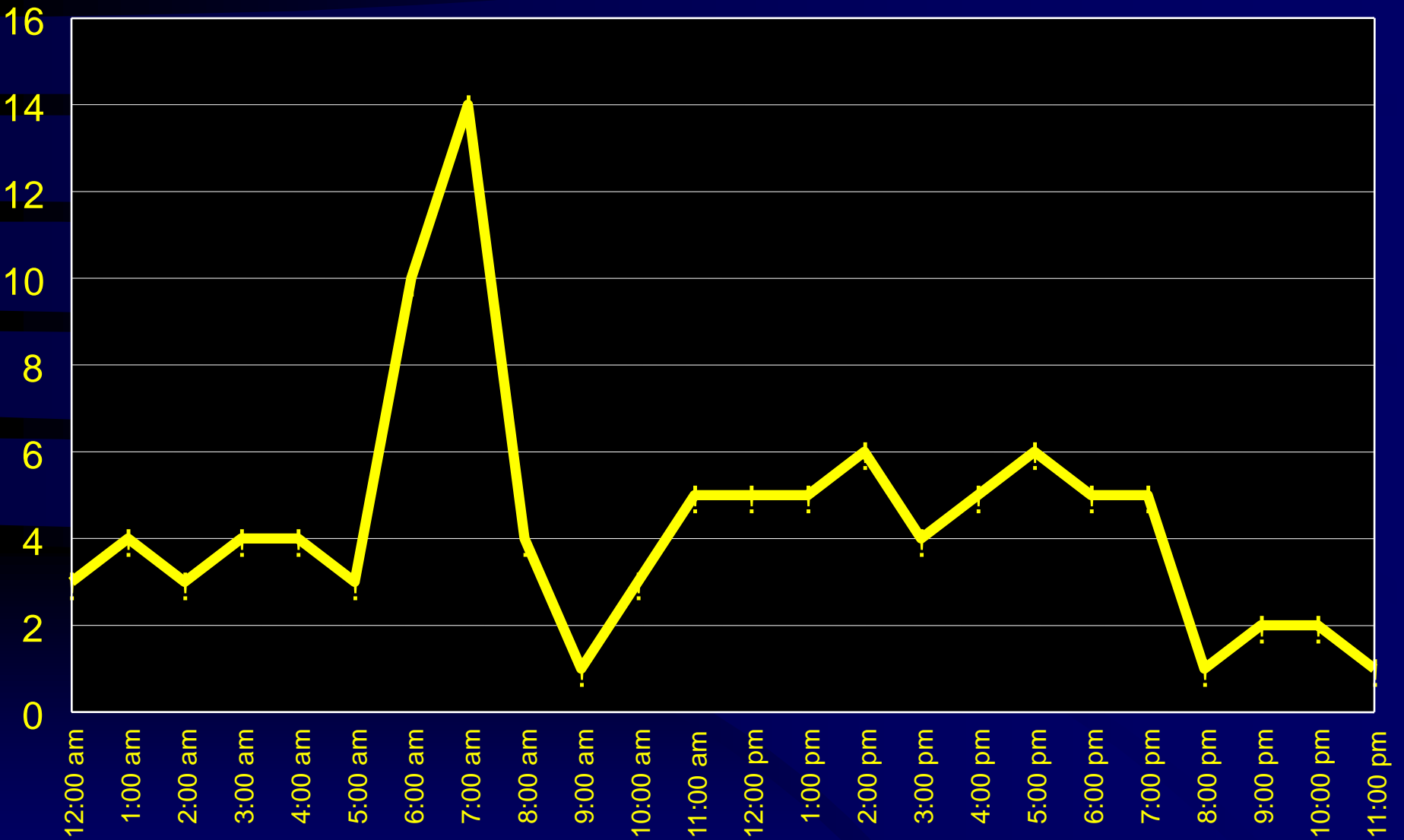
# Crashes 1993 - 1997 Smoke and Fog

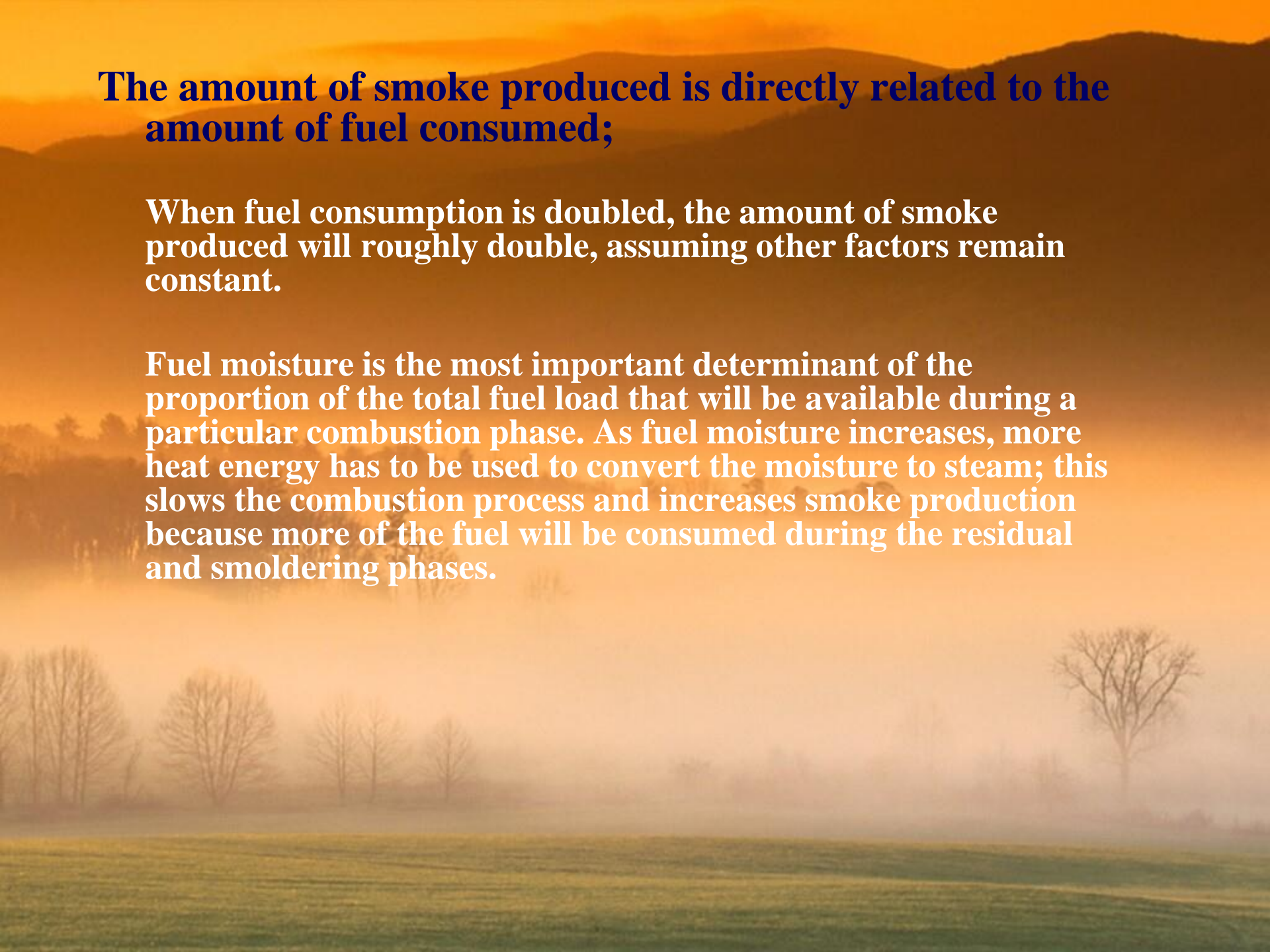
Smoke (# Accidents)

Fog (# of Accidents)



# Accidents by Hour of the Day





**The amount of smoke produced is directly related to the amount of fuel consumed;**

**When fuel consumption is doubled, the amount of smoke produced will roughly double, assuming other factors remain constant.**

**Fuel moisture is the most important determinant of the proportion of the total fuel load that will be available during a particular combustion phase. As fuel moisture increases, more heat energy has to be used to convert the moisture to steam; this slows the combustion process and increases smoke production because more of the fuel will be consumed during the residual and smoldering phases.**

# **The amount of smoke produced is directly related to the amount of fuel consumed;**

**The combustion of damp fuels generates smoke that contains a large amount of water vapor, which, although not a pollutant, has a substantial adverse affect on visibility. Remember that live green fuels and damp fuels, whether live or dead, will significantly increase the amount of moisture in smoke. Burning when fine fuel moisture is fairly low is recommended because less energy is needed to drive off moisture, which means:**

- More heat energy is available to preheat additional fuels**
- Fuels reach ignition temperature quicker**
- More fuel is available**
- Combustion efficiency is increased**
- Rate of spread and flame length increase resulting in higher fire line intensity**
- More of the emissions will be entrained into the smoke plume**
- The plume will be lofted higher into the atmosphere**

# **Fuel Characteristics Affecting the Volume of Smoke Produced**

- Type of fuel
- Fuel moisture and size
- Fuel arrangement / Fuels that are more compact
- Amount of fuel (loading)





# **Basic Objectives of Smoke Management**

- **Identify and avoid smoke sensitive areas**
- **Disperse and dilute smoke**
- **Reduce emissions**







Questions?

